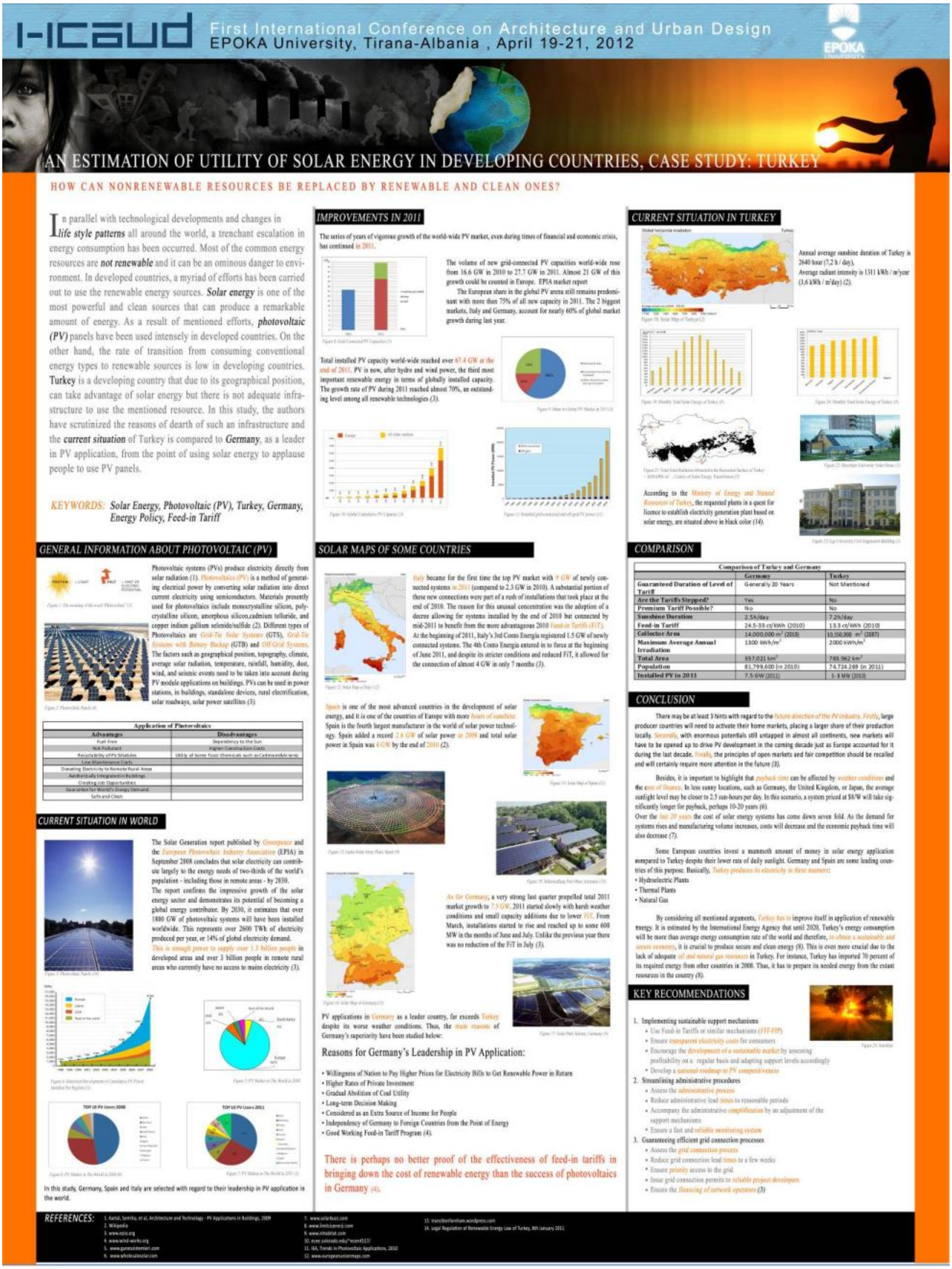

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AN ESTIMATION OF UTILITY OF SOLAR ENERGY IN DEVELOPING COUNTRIES, CASE STUDY: TURKEY

HOW CAN NONRENEWABLE RESOURCES BE REPLACED BY RENEWABLE AND CLEAN ONES?

In parallel with technological developments and changes in *life style patterns* all around the world, a trenchant escalation in energy consumption has been occurred. Most of the common energy resources are ***not renewable*** and it can be an ominous danger to environment. In developed countries, a myriad of efforts has been carried out to use the renewable energy sources. ***Solar energy*** is one of the most powerful and clean sources that can produce a remarkable amount of energy. As a result of mentioned efforts, ***photovoltaic (PV)*** panels have been used intensely in developed countries. On the other hand, the rate of transition from consuming conventional energy types to renewable sources is low in developing countries. **Turkey** is a developing country that due to its geographical position, can take advantage of solar energy but there is not adequate infrastructure to use the mentioned resource. In this study, the authors have scrutinized the reasons of dearth of such an infrastructure and the ***current situation*** of Turkey is compared to **Germany**, as a leader in PV application, from the point of using solar energy to applause people to use PV panels.

KEYWORDS: *Solar Energy, Photovoltaic (PV), Turkey, Germany, Energy Policy, Feed-in Tariff*

GENERAL INFORMATION ABOUT PHOTOVOLTAIC (PV)

Figure 1: The meaning of the word "Photovoltaic" (1)

Photovoltaic systems (PVs) produce electricity directly from solar radiation (1). Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors. Materials presently used for photovoltaics include monocrystalline silicon, polycrystalline silicon, amorphous silicon,cadmium telluride, and copper indium gallium selenide/sulfide (2). Different types of Photovoltaics are Grid-Tie Solar Systems (GTS), Grid-Tie Systems with Battery Backup (GTB) and Off-Grid Systems. The factors such as geographical position, topography, climate, average solar radiation, temperature, rainfall, humidity, dust, wind, and seismic events need to be taken into account during PV module applications on buildings. PVs can be used in power stations, in buildings, standalone devices, rural electrification, solar roadways, solar power satellites (3).

Figure 2: Photovoltaic Panels (4)

Application of Photovoltaics	
Advantages	Disadvantages
Fuel Free	Dependency to the Sun
Not Pollutant	Higher Construction Costs
Recyclability of PV Modules	Utility of Some Toxic Chemicals such as Cadmium [illegible]
Low Maintenance Costs	
Donating Electricity to Remote Rural Areas	
Aesthetically Integrated in Buildings	
Creating Job Opportunities	
Good answer for World's Energy Demand	
Safe and Clean	

CURRENT SITUATION IN WORLD

Figure 3: Photovoltaic Panels (4)

The Solar Generation report published by Greenpeace and the European Photovoltaic Industry Association (EPIA) in September 2008 concludes that solar electricity can contribute largely to the energy needs of two-thirds of the world's population - including those in remote areas - by 2030.

The report confirms the impressive growth of the solar energy sector and demonstrates its potential of becoming a global energy contributor. By 2030, it estimates that over 1800 GW of photovoltaic systems will have been installed worldwide. This represents over 2600 TWh of electricity produced per year, or 14% of global electricity demand. This is enough power to supply over 1.3 billion people in developed areas and over 3 billion people in remote rural areas who currently have no access to mains electricity (3).

Figure 4: Historical Development of Cumulative PV Power Installed Per Region (3)

Figure 5: PV Market in The World in 2009

Figure 6: PV Market in The World in 2008 (4)

Figure 7: PV Market in The World in 2011 (3)

In this study, Germany, Spain and Italy are selected with regard to their leadership in PV application in the world.

IMPROVEMENTS IN 2011

The series of years of vigorous growth of the world-wide PV market, even during times of financial and economic crisis, has continued in 2011.

Figure 8: Grid Connected PV Capacities (3)

The volume of new grid-connected PV capacities world-wide rose from 16.6 GW in 2010 to 27.7 GW in 2011. Almost 21 GW of this growth could be counted in Europe. EPIA market report

The European share in the global PV arena still remains predominant with more than 75% of all new capacity in 2011. The 2 biggest markets, Italy and Germany, account for nearly 60% of global market growth during last year.

Total installed PV capacity world-wide reached over 67.4 GW at the end of 2011. PV is now, after hydro and wind power, the third most important renewable energy in terms of globally installed capacity. The growth rate of PV during 2011 reached almost 70%, an outstanding level among all renewable technologies (3).

Figure 9: Share in Global PV Market in 2011 (3)

Figure 10: Global Cumulative PV Capacity (3)

Figure 11: Installed grid-connected and off-grid PV power (11)

SOLAR MAPS OF SOME COUNTRIES

Figure 12: Solar Map of Italy (12)

Italy became for the first time the top PV market with 9 GW of newly connected systems in 2011 (compared to 2.3 GW in 2010). A substantial portion of these new connections were part of a rush of installations that took place at the end of 2010. The reason for this unusual concentration was the adoption of a decree allowing for systems installed by the end of 2010 but connected by mid-2011 to benefit from the more advantageous 2010 Feed-in Tariffs (FiT).

At the beginning of 2011, Italy's 3rd Conto Energia registered 1.5 GW of newly connected systems. The 4th Conto Energia entered in to force at the beginning of June 2011, and despite its stricter conditions and reduced FiT, it allowed for the connection of almost 4 GW in only 7 months (3).

Spain is one of the most advanced countries in the development of solar energy, and it is one of the countries of Europe with more hours of sunshine. Spain is the fourth largest manufacturer in the world of solar power technology. Spain added a record 2.6 GW of solar power in 2008 and total solar power in Spain was 4 GW by the end of 2010 (2).

Figure 14: Solar Map of Spain (12)

Figure 13: Gemasolar Solar Power Plant, Spain (9)

Figure 15: [illegible], Germany (13)

Figure 16: Solar Map of Germany (12)

As for Germany, a very strong last quarter propelled total 2011 market growth to 7.5 GW. 2011 started slowly with harsh weather conditions and small capacity additions due to lower FiT. From March, installations started to rise and reached up to some 600 MW in the months of June and July. Unlike the previous year there was no reduction of the FiT in July (3).

Figure 17: Solar Park [illegible], Germany (9)

PV applications in Germany as a leader country, far exceeds Turkey despite its worse weather conditions. Thus, the main reasons of Germany's superiority have been studied below:

Reasons for Germany's Leadership in PV Application:

- Willingness of Nation to Pay Higher Prices for Electricity Bills to Get Renewable Power in Return
- Higher Rates of Private Investment
- Gradual Abolition of Coal Utility
- Long-term Decision Making
- Considered as an Extra Source of Income for People
- Independency of Germany to Foreign Countries from the Point of Energy
- Good Working Feed-in Tariff Program (4).

There is perhaps no better proof of the effectiveness of feed-in tariffs in bringing down the cost of renewable energy than the success of photovoltaics in Germany (4).

CURRENT SITUATION IN TURKEY

Figure 18: Solar Map of Turkey (2)

Annual average sunshine duration of Turkey is 2640 hour (7,2 h / day),
Average radiant intensity is 1311 kWh / m²year (3,6 kWh / m²day) (2).

Figure 19: Monthly Total Solar Energy of Turkey (4)

Figure 20: Monthly Total Solar Energy of Turkey (4)

Figure 21: Total Solar Radiation Intensities in the Horizontal Surface of Turkey – kWh/m² [illegible] (1)

Figure 22: [illegible] University Solar House (1)

According to the Ministry of Energy and Natural Resources of Turkey, the requested plants in a quest for licence to establish electricity generation plant based on solar energy, are situated above in black color (14).

Figure 23: [illegible] University Civil Engineers Building (1)

COMPARISON

Comparison of Turkey and Germany		
	Germany	Turkey
Guaranteed Duration of Level of Tariff	Generally 20 Years	Not Mentioned
Are the Tariffs Stepped?	Yes	No
Premium Tariff Possible?	No	No
Sunshine Duration	2.5h/day	7.2h/day
Feed-in Tariff	24.5-33 ct/kWh (2010)	13.3 ct/kWh (2010)
Collector Area	14,000,000 m² (2010)	10,150,000 m² (2007)
Maximum Average Annual Irradiation	1300 kWh/m²	2000 kWh/m²
Total Area	357,021 km²	783,562 km²
Population	81,799,600 (in 2010)	74,724,269 (in 2011)
Installed PV in 2011	7.5 GW (2011)	5 - 8 MW (2010)

CONCLUSION

There may be at least 3 hints with regard to the future direction of the PV industry. Firstly, large producer countries will need to activate their home markets, placing a larger share of their production locally. Secondly, with enormous potentials still untapped in almost all continents, new markets will have to be opened up to drive PV development in the coming decade just as Europe accounted for it during the last decade. Finally, the principles of open markets and fair competition should be recalled and will certainly require more attention in the future (3).

Besides, it is important to highlight that payback time can be affected by weather conditions and the cost of finance. In less sunny locations, such as Germany, the United Kingdom, or Japan, the average sunlight level may be closer to 2.5 sun-hours per day. In this scenario, a system priced at $8/W will take significantly longer for payback, perhaps 10-20 years (6).

Over the last 20 years the cost of solar energy systems has come down seven fold. As the demand for systems rises and manufacturing volume increases, costs will decrease and the economic payback time will also decrease (7).

Some European countries invest a mammoth amount of money in solar energy application compared to Turkey despite their lower rate of daily sunlight. Germany and Spain are some leading countries of this purpose. Basically, Turkey produces its electricity in three manners:

- Hydroelectric Plants
- Thermal Plants
- Natural Gas

By considering all mentioned arguments, Turkey has to improve itself in application of renewable energy. It is estimated by the International Energy Agency that until 2020, Turkey's energy consumption will be more than average energy consumption rate of the world and therefore, to obtain a sustainable and secure economy, it is crucial to produce secure and clean energy (8). This is even more crucial due to the lack of adequate oil and natural gas resources in Turkey. For instance, Turkey has imported 70 percent of its required energy from other countries in 2008. Thus, it has to prepare its needed energy from the extant resources in the country (8).

KEY RECOMMENDATIONS

Figure 24: Sunrise

1. Implementing sustainable support mechanisms
   - Use Feed-in Tariffs or similar mechanisms (FIT-FIP)
   - Ensure transparent electricity costs for consumers
   - Encourage the development of a sustainable market by assessing profitability on a regular basis and adapting support levels accordingly
   - Develop a national roadmap to PV competitiveness
2. Streamlining administrative procedures
   - Assess the administrative process
   - Reduce administrative lead times to reasonable periods
   - Accompany the administrative simplification by an adjustment of the support mechanisms
   - Ensure a fast and reliable monitoring system
3. Guaranteeing efficient grid connection processes
   - Assess the grid connection process
   - Reduce grid connection lead times to a few weeks
   - Ensure priority access to the grid
   - Issue grid connection permits to reliable project developers
   - Ensure the financing of network operators (3)

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